Automated TIG Welding Control System

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Category:
Control Design

NI Products Used: LabVIEW 7 Express, LabVIEW 7 Express Real-Time Module
LabVIEW Enterprise Connectivity Toolkit, NI DAQ Hardware, NI Motion Hardware,
NI PXI Chassis and Controllers

Pull Quote: The NI PXI-based TIG welding system provided the flexibility in performing various weld jobs while saving substantial time and a quarter of the cost of an off-the-shelf TIG welding control system.

The Challenge: Implementing a reliable and programmable control platform for Tungsten Inert Gas (TIG) welding systems.

The Solution: Using NI hardware tools and LabVIEW software to develop a TIG control system.

Creating a TIG Welding Control System
TIG welding is a shortened name for Tungsten Inert Gas welding process. The TIG welding process uses a tungsten electrode to conduct electric current to the arc, creating a very precise and local heat zone. This makes the TIG welding process ideal for use where it is critical not to heat very large areas. The TIG weld puddle and electrode are protected from atmospheric contaminants by a shield of inert gas. The inert gases used in this process are Helium and/or Argon. Inert gases do not combine with atmospheric gases, which make them ideal for shielding the weld puddle and heat zone.

The TIG welding power source should be an AC/DC welder with a high duty cycle. This welder should also have a high frequency or HF generator either built into or added onto the machine. The high frequency feature is necessary to maintain a stable arc during the zero voltage conditions in the alternating current cycle. The TIG torch is designed to deliver both electric current and shielding gas to the weld joint.

The RT Series PXI embedded controller-based welding system was designed for two different welding stations:

Station I (XY-Positioner)
This station is used for welding object on a XY plane. This station consisted of two DC motors, which are used in controlling the position of the weld object with respect to the weld head. The object is moved on a XY plane in predefined profile. Along this profile the weld head performs the welding. Here, the required arc distance also determines the

position of the weld head and again a stepper motor controls it. The weld voltage needs to be maintained at a constant level during the entire welding process. Two encoders provide the XY position information.

Station II (Lathe)
This station is used for welding cylindrical object. The station consisted of a servomotor to which the weld object is coupled. This motor is used for giving a rotation to the object to be welded during the welding process. This is an open loop servomotor, which is rotated for a fixed duration of time. The two pieces to be welded are tightly aligned and fixed to the fixture and it is coupled to the servomotor. The weld head position is adjusted by using a stepper motor. This stepper motor positions the weld head to meet the required arc distance. Thus, this stepper motor acts as an arc distance controller. For getting a good uniform weld the arc distance should be maintained at a constant level. This is accomplished by taking the weld voltage feedback. This voltage should be constant through out the welding process.

Software
First the user has to login with a valid password. Only if the user has administrator privileges will be able to modify employee database, recipe database, and control parameters. After logging on to the system the user can select the recipe type. The corresponding recipe is then transmitted to the RT Series PXI embedded controller system through TCP/IP. The host system provides a display screen for monitoring the test. The RT Series embedded controller will check for parameters like weld current, control on, emergency off, weld-voltage, and send the feed back to the host system. All these are indicated in the host system, once these statuses are "OK," the test will proceed. During the test the host will be getting continuous feed back from the RT Series embedded controller system of all the parameters, these values will be displayed on the host system along with the set values.
After the test is completed the following reports are generated

- Master report with all the records of the weld job with date and time and the serial no.
- Report of the set values vs. the actual values.

A Brief Description of Software Features Developed on LabVIEW 7.0 and LabVIEW 7 Real-Time:

- The software has the option for entering parameters such as arc voltage, weld current, travel speed in terms of RPM in case of lathe motor or mm/min in case of XY table, XY position co-ordinates, set values of peak and background current, average current, pulse per second, pulse width and duration of weld cycle will to be monitored and displayed in real time. Weld current and voltage will be displayed graphically in real time.
- The software provides option for generating welding profiles linear, circular rectangular profiles with XY positioner.

- Provision has been made for creating program for welding any profiles imported from Auto-CAD.
- The software has provision for entering welding related parameter and create a program and store it. These programs can be called later on to perform a welding job.
- The software has feature for accepting command from a wireless pendant and perform the required action on pressing a key on the pendant.
- The software performs the welding control action along with the gas flow control.
- The software has feature for recipe generation for welding.

Hardware

The functional role assigned to each hardware component is as per the following table:

Hardware	**Functional Role**
PXI-8176	TIG welding system controller
PXI-1042	Chassis
PXI-7344	Motion controller for XY-position stepper motor, lathe servomotor and arc distance control stepper motor controller.
PXI-6025E	Data acquisition, DIO, and for setting welding current.
NI UMI-7764	Universal motion interface for third-party drive.
Power-Master	Lathe servo motor's drive
EAC	XY-position motors's drive
NuDrive 2SX-411	ARC distance control motor's drive
Desktop PC	User interface.

A Brief Description of Software-Controlled Weld Event Sequence Taken Care of By PXI

The welding operation starts with the setting of the weld gap that is the arc distance. Once the arc distance is set, the flow of backup gas is started. Once the backup gas starts flowing, the torch gas flow is also started. After a prepurge time, which is a fixed duration of time after the backup gas flow has started, the weld current starts flowing. The weld current increases and it reaches the set current after an upslope time. During this up slope time, the current reaches the set weld current and the current remain at that level during entire weld period. Once the level time for the welding current is over the current is decreased within a down-slope time. Once down-slope time is over, the arc is extinguished by reducing the current to zero.

During the weld duration, we can enable the arc distance control by taking a feedback of the weld voltage and controlling the arc distance motor w.r.t this voltage. This is necessary if the object to be welded is not of uniform surface height. Also, after the weld duration is over the torch gas and the backup gas continues to flow for a post-purge time.

With the NI Real-Time Series PXI embedded controllers, we were able to develop an extremely reliable, rugged, and highly precise control system, many of the safety interlocks were moved to the real-time based software, therefore reducing wiring and improving the system reliability. The NI PXI-based TIG welding system provided the flexibility to perform various weld jobs while saving substantial time and a quarter of the cost of an off-the-shelf TIG welding control system.

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